

The mechanism of charge compensation in Cu-Fe-PGE thiospinels from the Penikat layered intrusion, Finland

ANDREI Y. BARKOV,^{1,*} ROBERT F. MARTIN,¹ TAPIO A.A. HALKOAHO,² AND GLENN POIRIER¹

¹Department of Earth and Planetary Sciences, McGill University, 3450 University Street, Montreal, Quebec H3A 2A7, Canada

²Regional Office for Mid-Finland, Geological Survey of Finland, P.O. Box 1237, FIN-70211, Kuopio, Finland

ABSTRACT

Thiospinels of Cu-(Fe) and platinum-group elements (PGE) are relatively abundant in the Kirakkajuppura PGE deposit of the Penikat layered complex, Finland. In actinolite-clinoclone rock that is nearly base-metal sulfide-free and relatively poor in chromite, the thiospinels occur as subhedral or anhedral grains (up to 0.4 mm). They are members of the cuprorhodsite-ferrorhodsite and cuprorhodsite-malanite series, relatively poor in cuproiridsite, and display considerable grain-to-grain variations in Cu, Fe, Pt, and Rh. Strong negative Fe-Cu, Pt(+Ir)-Fe, Rh-Cu, and Rh-Pt and strong positive Pt(+Ir)-Cu and Rh-Fe correlations in these thiospinels are indicative of a coupled substitution: Fe-for-Cu substitution in the tetrahedral (A) sites causes an excess in formal positive charge, which is compensated by Rh-for-(Pt+Ir) substitution in the octahedral (B) sites. Probable valence states in the Fe-free and Fe-rich end-members of the solid-solution series at Penikat are $\text{Cu}^+[\text{Rh}^{3+}(\text{Pt},\text{Ir})^{4+}]_2\text{S}_4^{2-}$ and $(\text{Fe}_{0.5}^{3+}\text{Cu}_{0.5}^+)\text{Rh}_2^3\text{S}_4^{2-}$, and these suggest the heterovalent substitution scheme $^A\text{Fe}^{3+} + 2 ^B\text{Rh}^{3+} \rightarrow ^A\text{Cu}^+ + 2 ^B\text{Pt}^{4+} (+2 \text{Ir}^{4+})$ to incorporate Fe in the ferrorhodsite-rich end member.